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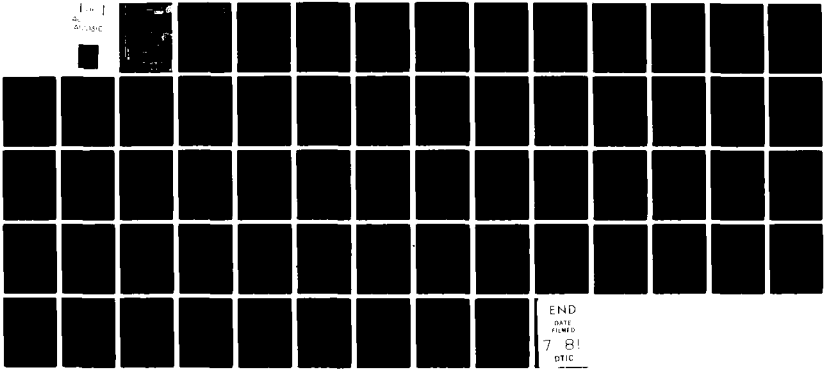

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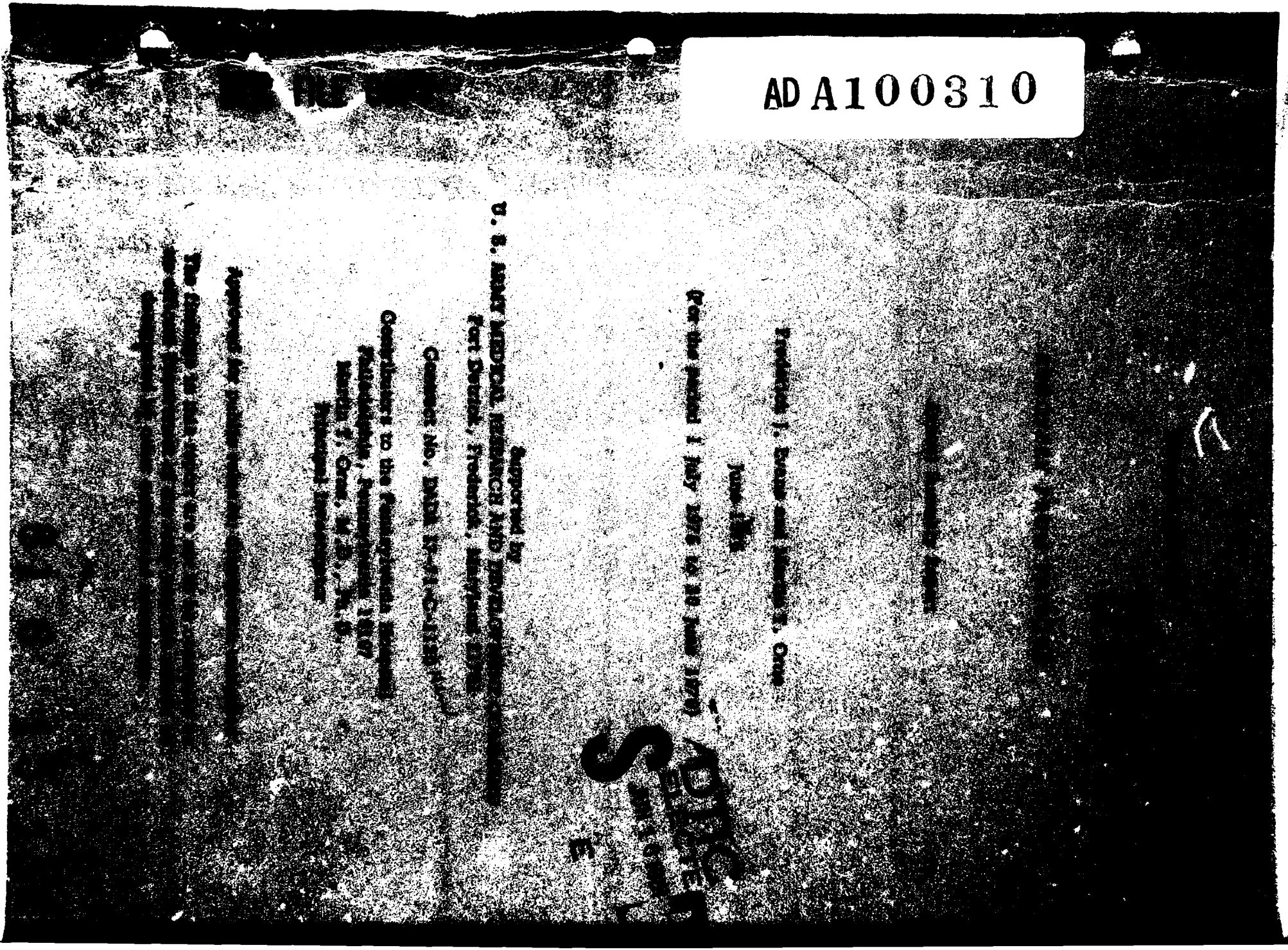

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The findings of the original napping questionnaire (based on 430 students) on differences between appetitive and replacement nappers, and between nappers and non-nappers, have been extended in a new sample of 469 students. This has served to validate several important conclusions about the functions of napping in the different subgroups. A special subgroup of subjects who were selected as appetitive nappers by the questionnaire but as replacement nappers by a blind interviewer have also been studied. This group was termed stress nappers because

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they seem to nap in response to stress-induced sleep disturbances, Moreover, their nap seems to be less restorative and may interfere with the subsequent night's sleep. This kind of napping pattern appears less useful in preventing fatigue but might be prognostic of future psychopathology. The central concept underlying the work concerns individual differences in the ability to control sleep processes. Unless such control can be taught to individuals not possessing the skill, attempts to teach prophylactic napping would be unsuccessful. The voluntary control of sleep processes may reflect a more general ability to control altered states of consciousness; consequently, we explored the relationship between responsivity to hypnosis and aspects of the napping questionnaire. While there were no differences between hypnotizable and unhypnotizable nappers, consistent and meaningful differences indicated that the hypnotizable non-nappers have a greater degree of control over sleep processes than insusceptible non-nappers (though still less than nappers in general). In some ways hypnotizable non-nappers are quite like nappers in the sense they possess this special ability, though perhaps they have learned to utilize this skill in alternative ways to napping. The potential value of techniques such as self-hypnosis to help modify sleep behavior is documented in a collaborative study. The implications of each of these sets of data, both in terms of our ongoing research programs, and in terms of understanding sleep functions and the efficiency of both recovering from fatigue and forestalling its occurrence are discussed.

Report Number 65

RECOVERY FROM FATIGUE

Annual Summary Report

Frederick J. Evans and Martin T. Orne

June 1976

(For the period 1 July 1975 to 30 June 1976)

Supported by
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Principal Investigator

Introduction

Our continuing aim has been to understand the functions of sleep in order to improve the efficiency with which the psychological and physiological benefits of sleep can be obtained. These studies are intended to provide an appropriate data base to pursue our major long term goal--to teach individuals to nap prophylactically. Long periods of quasi-continuous performance, and the sleep debt that tends to accumulate, lead to inefficient performance, and the need to sleep, often involuntarily at inopportune and even dangerous times, may become overwhelming. It is intended that individuals who are facing continuous performance situations learn to efficiently utilize any available opportunities to nap, even though the need for sleep is not then pressing. The ability to derive benefit from sleep in advance may not only forestall the decrement in effectiveness created by a progressively increasing sleep debt but should also allow the satisfaction of sleep needs in fewer hours than might be required to restore satisfactory performance and the feeling of well being once a serious sleep debt had been accumulated.

During the past two years we have carried out a major investigation on the nature of napping, emphasizing differences between those who derive considerable satisfaction from regular napping and those who avoid napping, apparently because of its undesirable consequences for them.

In our previous report we presented results based on analyses of (a) a napping questionnaire, designed to survey the parameters of and

attitudes towards napping, administered to 430 volunteer students; (b) the EEG recorded one-hour naps of 33 subjects selected by this questionnaire to represent criterion groups of consistent (at least once a week) nappers and habitual non-nappers; (c) the subsequent 15-day sleep diaries completed by these subjects concerning their daily sleep and napping habits. Much of the data presented then was based on our distinction between appetitive and replacement nappers. Appetitive nappers are people whose desire for napping seems to be unrelated to feelings of fatigue, tiredness, or sleep need. Their EEG during napping showed considerable cycling through light sleep and drowsiness. Replacement nappers are people who nap primarily to make up for lost sleep--their nap is in response to fatigue, presumably after nights of abbreviated sleep. Not surprisingly, their EEG during a nap (like the non-nappers who did sleep) contained consolidated sleep cycles like those seen at night. We have summarized several differences between the two napper types that appeared to confirm the validity of the distinction, and explored napping questionnaire, EEG nap, and sleep diary differences between the two napper groups and non-nappers. A major, and consistent, finding was that nappers appeared to have more voluntary control over sleep onset than non-nappers.

This research has now been extended in three directions, and a detailed summary of the findings will be presented below.

(a) We have extended the findings of the original napping questionnaire (based on 430 students) on differences between appetitive and replacement nappers, and between nappers and non-nappers, in a new sample of

469 students. This has also served to validate several of the important conclusions we had drawn about the functions of napping in the different subgroups.

(b) We have further studied a special subgroup of subjects who were selected as appetitive nappers by the questionnaire but as replacement nappers by a blind interviewer. This group we have termed stress nappers. They seem to nap in response to stress-induced sleep disturbances. Moreover, their nap seems to be less restorative and may interfere with the subsequent night's sleep. This kind of napping pattern may prove less useful in preventing fatigue and might be prognostic of future psychopathology.

(c) The central concept underlying much of the work concerns individual differences in the ability to control sleep processes. Unless such control can be taught to individuals not possessing the skill, attempts to teach prophylactic napping would be unsuccessful. The voluntary control of sleep processes may reflect a more general ability to control altered states of consciousness; consequently, we are exploring the relationship between responsivity to hypnosis and aspects of the napping questionnaire ($N = 469$). While there are no differences between hypnotizable and unhypnotizable nappers, consistent and meaningful differences indicated that the hypnotizable non-nappers have a greater degree of control over sleep processes than insusceptible non-nappers (though still less than nappers in general). In some ways hypnotizable non-nappers are quite like nappers in the sense they possess this special ability, though perhaps they have

learned to utilize this skill in alternative ways to napping. The potential value of techniques such as self-hypnosis to help modify sleep behavior is documented in a collaborative study.

The implications of each of these sets of data, both in terms of our ongoing research programs, and in terms of understanding sleep functions and the efficiency of both recovering from fatigue and forestalling its occurrence are discussed.

Extension of Questionnaire Study

The questionnaire data, which provided one of the criteria for the original classification of individuals as appetitive, replacement, or non-nappers, was administered to a sample of 512 subjects who were regular students in a large introductory psychology course. These subjects were asked to take the questionnaire home, complete it, and return it by mail to the laboratory. They were encouraged to participate in the study by their professor and were paid $2 in advance for their participation in this research. Based on previous data, we had found that advance payment of this kind was most efficient in inducing subjects to respond since the guilt induced by not carrying out an agreed upon commitment after having received payment in advance seems to be a more potent motivator of college students than the promise of a $2 reward for doing a tedious task. This procedure--as well as appropriate follow-up letters--resulted in a 93% rate of return (474 of 512). Previous data analysis was completed on the first 430 questionnaires returned.

While this unusually high rate of return suggested that the sample

was representative of a class, it seemed desirable to extend our findings and cross validate in another large sample of subjects who came to the laboratory and filled out their questionnaires at that time. The replication sample consisted of 469 subjects, mostly freshmen students from the several campuses in the Philadelphia area, who agreed to come to the laboratory to participate in ongoing research. Subjects were tested in 25 groups, ranging from 8 to 30 in size

The basic method of analysis was similar to that previously employed. In order to facilitate comparison between the two sets of results, comparative data from this sample were transcribed against all of the textual and tabular data presented in last year's progress report. Overall, a surprisingly close replication of the major findings previously reported was obtained. For the most part, differences previously reported as significant turned out to be similarly significant in the new sample and remarkably few differences emerged that had not previously been noted.

In all of the comparisons to be discussed below, the first number will always refer to the original sample of 430 and the second value or significance level will always refer to the replication sample of 469.

Frequency of Napping

The distribution of answers to the key question, "Do you take catnaps during the day?" is presented in Table 1. The frequency of nappers (who answered this question "sometimes," "usually," or "always") and nonnappers (who answered it "rarely" or "never") is also presented for both samples, along with the distribution of appetitive and replacement napper types.

Table 1

Distribution of Responses Concerning Frequency of Napping, and Frequency of Appetitive and Replacement Nappers

Do you take catnaps?	Percent frequency	
	Original Sample N = 430	Replication Sample N = 469
Non-Nappers:		
Never	7%	11%
Rarely	32%	34%
Total	39%	45%
Nappers:		
Sometimes	47%	43%
Usually	12%	11%
Always	2%	1%
Total	61%	55%
Napper Types:		
Appetitive	22%	34%
Replacement	78%	66%
N	261	259

There were, respectively, 39.3% and 44.8% of the students who reported "rarely" or "never" napping and who were essentially classified as non-nappers. Only 19% and 23% claim they "never" nap. Thus, 60% and 55% of students report that they at least sometimes take catnaps during the day. Of the nappers, 3% and 2% indicated they "always" napped and 21% and 20% indicated they "usually" napped, leaving 76% and 78% of nappers indicating "sometimes." Of the 261 and 259 nappers, 21.6% and 33.6% of the subjects were classified as appetitive nappers (answering "definitely yes" or "possibly yes" to the question: "Do you nap even when you do not feel tired?") and the remainder, replacement nappers (who answered the same question "possibly no" or "definitely no").

Sleep Parameters of Nappers and Non-Nappers

There was a marked similarity among the sleep parameters reported in each sample. The questions referred to the "last night" and typical length of sleep, time to fall asleep, time to bed, time awakened in the morning, etc. For example, the mean time slept was 7 hours, 26 minutes (S.D. = 1 hour, 51 minutes) and 7 hours, 20 minutes (S.D = 1 hour, 36 minutes) respectively for all subjects in each sample. In both instances the variability of their reported time slept for "last night" compared to "usually" was significantly greater ($p < .001$; $p < .01$). As before, this variability between "usually" and "last night" appeared to be a function of the more variable "last night" answer of the replacement nappers. However, in the replication sample some of the questions concerning subjective satisfaction of sleep (such as, "Do you sleep as deeply as you would like to?" "Do you typically

sleep well?" and "Do you wake up feeling slow and lethargic?" "Did you get enough sleep?") did not discriminate significantly between nappers and non-nappers. Differences in the time of going to bed and waking up in the morning were trivial and did not support the earlier trend noted for nappers to go to bed earlier and wake up earlier.

Napping and the Control of Sleep

As before, nappers more frequently report that they could go to sleep "right now" ($p < .0001$, $p < .0001$) and typically fall asleep more easily during the night ($p < .01$, $p < .002$), compared to non-nappers. Thus, as before, the nappers seem to have a greater readiness to be able to sleep and report an ability to fall asleep more easily at nighttime. These results are as predicted, because the ease and readiness to fall asleep along with the propensity to nap are the main defining variables in the voluntary control of sleep dimension isolated in our previous factor analytic study.

The concept of the voluntary control of sleep as an important ability possessed by some people is a central one in the development of our research program. One of the more striking findings in the previous report was the ease with which nappers could fall asleep in a wide variety of circumstances. Answers to ten questions asking about whether or not the subject tends to fall asleep under certain specified conditions are summarized in Table 2 for nappers and non-nappers for both samples. The remarkable consistency of this data leads to the strong conclusion that the voluntary ability to fall asleep in a wide variety of circumstances is a major characteristic discriminating between nappers and non-nappers. Any attempt to teach individuals to nap effectively in advance of continuous performance will involve training

Table 2

The Ease of Falling Asleep in Specific Situations

for Nappers and Non-Nappers in Two Samples

Do you fall asleep:	Original Sample			Replication Sample		
	Non-Napper N=169	Napper N=261	p<	Non-Napper N=210	Napper N=259	p<
On long car trips	2.75	3.13	.0001	2.63	3.30	.0001
While reading a book	2.25	2.72	.0001	2.36	2.76	.0001
While studying	2.06	2.56	.0001	2.32	2.64	.0002
During a play	1.35	1.54	.01	1.59	1.70	.20
On plane or train trips	2.37	2.68	.01	2.34	2.87	.0001
While watching movie	1.73	1.99	.002	1.85	2.00	.05
During lectures and speeches	1.82	2.25	.0001	2.11	2.42	.0001
At times of stress	1.61	1.81	.05	1.75	2.03	.002
While watching TV	2.28	2.46	.05	2.51	2.64	.10
After a particularly good meal	2.11	2.56	.0001	2.29	2.82	.0001
Fall asleep readily?	3.36	3.66	.01	3.48	3.73	.002
Fall asleep now? (yes=1, no=0)	.50	.79	.0001	.47	.79	.0001

Note:-Except for last two questions, all answers were rated on 5-point scale: 5 = Always, 1 = Never.

in this kind of control.

While the data is not tabulated, it is worth commenting in this regard that there are some minor differences between appetitive and replacement nappers on these questions. However, only one of these replicated satisfactorily. In both samples appetitive nappers are more likely to nap in times of stress than replacement nappers. The means of 2.21 and 2.23 for appetitive nappers differ significantly from the means of 1.73 and 1.94 for the replacement nappers ($p < .01$, $p < .05$) in the two samples. We will comment further on this finding in another section.

If the number of situations checked with the extreme category "5" or "always" is summed across these ten questions, the mean degree of voluntary control of sleep for various circumstances for nappers was greater than for non-nappers ($p < .0001$, $p < .001$). However, appetitive and replacement nappers did not differ.

Sleep Parameters in Appetitive and Replacement Nappers

There are relatively few differences in the overall sleep parameters between appetitive and replacement nappers. However, appetitive nappers nap more often. In spite of the restricted range imposed by the selection variable, their mean response to the question, "Do you take catnaps?" was significantly greater ($p < .05$, $p < .05$) than replacement nappers, and the mean frequency of napping of 16.9 and 15.8 naps per month is significantly greater than the means of 12.8 and 13.3 for the replacement nappers ($p < .05$, $p < .05$).

Replacement nappers more often have the feeling of having slept for

too short a time than either non-nappers ($p < .01$, $p < .05$) or appetitive nappers ($p < .10$, $p < .10$), and also feel that they typically need more sleep ($p < .10$, $p < .01$) than all other subjects. Thus there is evidence that replacement nappers have a subjective need for more sleep, particularly when they feel that they have come up on the short side of what they perceive they typically need. This subjectively perceived need for more sleep presumably provides the basis for the replacement napper's need to nap and his decision to do so.

Napping Characteristics in Appetitive and Replacement Subgroups

As already noted, the strongly observed ability to fall asleep whenever and wherever he chooses discriminates between the napper and non-napper in many ways in this questionnaire. However, there is very little difference in the capacity of appetitive and replacement nappers to do so. As was previously found, the appetitive napper significantly rates himself as more frequently taking naps, preferring to nap daily, napping as regularly as possible, and voluntarily napping whenever time permits.

One important finding is that appetitive nappers tend to fall asleep in times of stress more often when compared to either the replacement nappers ($p < .01$, $p < .05$) or non-nappers ($p < .005$, $p .001$). This confirms the hypothesis that the appetitive nappers' tendency to fall asleep is more in response to psychological factors than to factors related to general fatigue or sleep deprivation. However, in the next section we will discuss a third napper type consisting of individuals who answer this questionnaire like an appetitive napper but who have other characteristics more like those of a

replacement napper. These people nap mostly to make up for stress-induced insomnia.

A particularly important finding is that the replacement napper is much more likely to nap if he considers that he has not had a regular night's sleep the night before. The respective means for replacement nappers of 3.44 and 3.33 both differ significantly ($t = 3.25$; $p < .0002$, and $t = 6.29$; $p < .00001$) than the respective means of the appetitive nappers of 2.70 and 2.61 on the 5-point rating scale. Thus, the replacement napper seems to be napping in response to a perceived sleep deficit.

Although many other comparisons were made between appetitive and replacement nappers, none were significant. Of some interest was the lack of difference between the frequency of involuntary naps. Indeed, nappers tend not to report napping involuntarily very frequently. These results again support the conclusions that the appetitive napper can more readily take naps when he chooses to, that he enjoys napping as frequently as possible, and he derives a benefit from the nap that is not necessarily related to his physiological needs for sleep. In contrast, although the replacement napper has a similar capacity to fall asleep when he wants to, he chooses to do so in response to either perceived or real sleep needs, both in terms of the amount of sleep he believes he needs and in terms of his having obtained insufficient sleep on the nights before napping.

Napping Parameters

Table 3 reports mean time subjects take appetitive and replacement naps, length of nap, and similar details. While there are no significant

Table 3

Differences in Subjective Sleep Characteristics for

Appetitive and Replacement Nappers in Two Samples

Variable	Appet. (N=43)	Replac. (N=156)	p<	Appet. (N=87)	Replac. (N=172)	p<
Nap frequency per month	16.91	12.79	.05	3.96	3.33	.10
Hrs. til could nap again	4.14	4.54	.10	5.16	6.35	.001
Take catnaps	3.51	3.26	.05	3.33	3.19	.05
Could nap daily	3.30	3.00	.02	3.34	2.84	.0001
Like to nap regularly	3.14	2.80	.02	3.05	2.66	.01
Voluntarily nap if time	3.53	3.17	.002	3.31	3.12	.10
No nap if regular sleep previous night	2.70	3.44	.0002	2.61	3.33	.0001
Nap when <u>not</u> tired[a]	3.12	1 35	.0001	3.16	1.53	.0001

Note:- Except for the first two variables, all questions involve 5-point rating scales where 5 = Always and 1 = Never.

[a]Selection variable

differences between appetitive and replacement nappers in terms of the estimated clock parameters, the consistency between the two sets of data is remarkable. Thus, on the average nappers prefer to nap at 3:49 and 3:43 P.M. respectively in the two samples. The typical nap lasts 73 or 74 minutes; the average longest nap is 158 or 168 minutes, although the ideal nap would actually last 100 or 97 minutes in the two respective samples. In both samples the nappers reported it took them an average of 9 minutes to fall asleep when having a nap and in both samples this was in striking contrast to the typical 20 minutes it takes the same subject to fall asleep at night. In general, the replication data supports the earlier conclusion that in spite of the differences in the reasons for napping, there are no differences in the two groups in the length of the longest, shortest, or typical ideal nap.

Summary

Data from these two samples support most of our predictions about the characteristics of napping and also about the different kinds of nappers. This is particularly encouraging considering the vastly different circumstances under which subjects completed the two sets of questionnaires and gives us considerably enhanced confidence in the validity of our findings for college age populations.

The main features of the two major napping types, in comparison with non-nappers, may be summarized much as they were in our last report. There were no important differences in the basic sleep parameters reported by subjects regarding typical nighttime sleep habits. Although nappers report

they can fall asleep more easily than non-nappers, they did not differ from non-nappers in clock time estimates of how long it takes them to fall asleep at night. However, there was substantial evidence that nappers have a greater facility to fall asleep easily and to voluntarily choose situations in which they can sleep. Nappers, and particularly appetitive nappers, are capable of sleeping in a variety of circumstances, many of which have little or nothing to do with tiredness or fatigue.

Our concept of appetitive and replacement nappers has been replicated and seems to be valid. Appetitive nappers seem to nap primarily for psychological reasons. They have a greater degree of control over the ease of falling asleep and tend to nap more frequently than replacement nappers. In particular, they are more likely to nap in response to stress, but they do not necessarily feel more refreshed or less tired when awakening from a nap. Future research will need to be directed at the general psychological functions served by the nap for these people. Coping with stress and reducing anxiety are two likely candidates, particularly in view of the findings that the appetitive napper cycles through light transitional sleep in which reverie occurs.

In contrast, replacement nappers are more variable in terms of when they go to sleep and get up in the morning, and how long they sleep at night. They are not likely to nap if they have had sufficient sleep the previous night and they typically report feeling less tired after they nap. In terms of EEG findings, their nap looks more like a segment of nighttime sleep. Apparently, napping for the replacement napper has the desired

recuperative effects from fatigue resulting from loss of sleep.

We discussed last year that non-nappers may be more heterogeneous than we expected in terms of their reasons for not napping--at least dividing them into those who do not because of the unpleasant physical and mental consequences of napping (the group we invited to nap in the laboratory) and those who once did but no longer do so because they do not have time. The latter non-nappers are not necessarily dissatisfied with napping, but rather share some characteristics of particularly replacement nappers. The discovery that these non-nappers are more hypnotizable than those who do not nap because of unpleasant consequences has important implications which will be discussed later.

A Third Type of Napper?

In order to select subjects for the laboratory nap study we sought to identify consistent non-nappers and appetitive or replacement nappers. This was accomplished by initially selecting on the basis of questionnaire responses and by subsequently interviewing each subject by an investigator who was blind as to the individual's questionnaire response and conducted an extensive interview concerning the individual's sleep pattern. Only subjects who were classified in the same fashion by both the questionnaire and the blind interviewer were included in the study. Whenever a discrepancy occurred between these two criterion measures, the individuals were excluded. Consequently 12 non-nappers, 11 appetitive nappers and 10 replacement nappers were included in the final study. A remarkably homogeneous group of 9 subjects who were categorized as appetitive nappers by

their questionnaires but identified as replacement nappers by the blind interviewer emerged. Our initial impressions were that this group of individuals did not completely share the characteristics of either replacement or appetitive nappers though they did share some important consistencies in their response to the questionnaires and to the interviews. Consequently it seemed appropriate to carefully review the data of this special group of 9 subjects who had responded consistently in their reported sleep patterns despite the fact that we had not a priori anticipated the emergence of the group. This subgroup of individuals was compared with the three other subgroups who had participated in the EEG nap study. More than other nappers, the incidence of napping in this group seems to have something to do with the effect of prior stress leading to temporary insomnia or sleep onset problems on the preceding night. While we are not yet confident of the precise nature of this kind of napping, the term stress napper seems a convenient and at the moment appropriate way to characterize this group.

Stress nappers differ in many ways from the other three subgroups, both in terms of the questionnaire response (on non-criterion items) and in terms of the laboratory sleep data, and it is thus probably appropriate to consider them as a distinct napping type if the present findings are replicated in subsequent research.

Questionnaire Differences Among Three Napper Subgroups

Some of the questions on which stress nappers differed from either appetitive or replacement nappers are summarized in Table 4. It should be

Table 4

Questionnaire Differences Between Appetitive, Replacement and Stress Nappers Who Came to Laboratory to Sleep

Variables	Napper Group			t		
	Appetitive N=11	Replacement N=10	Stress N=9	App.vs Rep.	App.vs Stress	Rep.vs Stress
Mins. to fall asleep	12	11	30		2.31*	2.36*
Hrs. regular sleep	7:49	7:19	6:50		2.17*	2.29*
Fall asleep readily	3.91	3.80	2.89		2.80**	2.24*
Naps per month	19.3	12.9	13.3	2.76**	2.20*	
Could nap every day	3.55	3.30	3.11		1.82$^{\phi}$	
No nap if regular sleep prev. night	2.45	3.60	3.89	3.19***	3.96***	1.95$^{\phi}$
Nap satis. if less prev. sleep	3.18	3.90	3.33	3.04***		1.74$^{\phi}$
Fall asleep after stress	2.55	1.80	2.22	2.08*	2.14*	
Diffic. fall asleep at night	2.09	2.50	3.67		3.37***	2.38*

Note:- $^{\phi}$ $p < .10$, * $p < .05$, ** $p < .02$, *** $p < .001$ (2-tailed values)

Except for first two entries, all variables rated on 5-point scale where 5 = Always, 1 = Never.

noted that these comparisons are post hoc in that they are based on subgroups determined by the blind interview. However, it was shown last year that the small subgroups chosen for the laboratory study did not differ from the larger questionnaire population from which they were drawn.

As a group, these 9 subjects reported regularly sleeping 6 hours and 50 minutes; significantly shorter than the 7 hours and 35 minutes ($t = 2.64$, $df = 29$, $p < .02$) of the 21 replacement and appetitive nappers who were correctly identified by the blind experimenter during the inquiry. They reported desiring fewer hours sleep than they typically obtained (7 hours, 48 minutes) compared to both of the napper subgroups (8 hours, 41 minutes, $t = 2.63$, $p < .02$). They typically fell asleep (1:30 A.M.) 1 hour, 7 minutes later than other nappers (12:23 A.M., $t = 2.36$, $p < .025$), but at about the same time as the non-nappers (1:06 A.M.). They reported more difficulty in falling asleep ($t = 2.97$, $p < .01$) and similarly were less likely to rate themselves as generally being able to fall asleep readily ($t = 2.71$, $p < .02$) compared with the remaining nappers. In each comparison outlined above, this puzzling group of subjects differed significantly from both the 11 appetitive and 10 replacement nappers, and they also failed to differ significantly in any of the measures from the 12 non-nappers.

While subjects in this stress napper subgroup usually fall asleep later than the other nappers, they do not differ from other nappers as to when they usually feel tired: each of the napper groups feels tired significantly earlier than non-nappers. Thus, these special stress nappers get tired about the same time as other nappers, but have more difficulty in

falling asleep than appetitive and replacement nappers, thereby falling asleep at a much later time. Whereas the appetitive and replacement nappers typically fall asleep within 12 minutes and 11 minutes of going to bed, these 9 subjects typically take 30 minutes ($t = 3.10$, $p < .01$; $t = 2.36$, $p < .05$). These subjects also rate themselves as having significantly more difficulty in falling asleep ($\bar{X} = 3.67$ on 5-point scale, 5 = always) than non-nappers ($\bar{X} = 2.50$, $t = 2.51$, $p < .02$), appetitive nappers ($\bar{X} = 2.09$, $t = 3.37$, $p < .001$) and replacement nappers ($\bar{X} = 2.50$, $t = 2.38$, $p < .05$). In addition, they were more likely than other nappers or non-nappers to rate themselves as often sleeping for too short a time ($t = 2.31$, $p < .05$). In general, this group of nappers have some of the characteristics of both appetitive and replacement sub-types. While they do have the ability to control sleep in a variety of circumstances, they nap less regularly than appetitive nappers and express less preference to do so. Like the replacement napper, their likelihood of napping and their satisfaction with the nap is more related to the previous night's sleep. The major difference from the other two groups is their more frequent difficulty in falling asleep.

While these differences seem to imply that this special group has some voluntary control over the sleep process, there may be periods of nighttime sleep when this does not hold. These subjects do not differ significantly from the nappers as a group in any of the ten situations in which they were asked if they could nap readily. Nevertheless the mean ratings for each of the situations typically fall between the non-nappers and combined napper groups. Thus, while they fall asleep more readily than non-nappers

on car trips ($t = 1.73$, $p < .10$), while reading a book ($t = 4.09$, $p < .001$), at a movie ($t = 1.84$, $p < .10$), and while watching a T.V. show ($t = 2.03$, $p < .10$), they do not differ from non-nappers on two other ratings--while studying and following a good meal (on which both appetitive and replacement nappers exceed non-nappers) nor on a third--while at lectures and speeches (a situation in which replacement nappers are more likely to fall asleep than non-nappers). These special subjects (mean rating = 2.22) are more like appetitive nappers (mean rating = 2.55) in only one of these ten situations. This is in times of stress: both subgroups differ significantly from replacement nappers (mean rating = 1.80) and also significantly from non-nappers ($t = 2.14$, $p < .05$; $t = 2.90$, $p < .02$, respectively). It seems that in spite of their difficulty in falling asleep at night, these subjects can readily decide to nap in a variety of situations--but not quite as readily as other nappers. However, like the appetitive napper, they have a pronounced ability to fall asleep in times of stress. Both this special subgroup ($t = 2.20$, $p < .05$) and replacement nappers ($t = 2.76$, $p < .02$) nap less frequently per month than the appetitive nappers. This subgroup reports preferring to nap earlier in the day (about 2:34 P.M) compared to other nappers (about 4:07 P.M., $t = 1.75$, $p < .10$). However, when asked what is the minimum time after awakening before a nap could be taken, they indicated sooner (4 hours, 19 minutes) than either replacement (6 hours, 39 minutes, $t = 2.29$, $p < .05$) or appetitive (6 hours, 14 minutes, $t = 2.13$, $p < .05$) nappers. Thus, while the need for napping is less frequent, when the need exists, it seems to be more pressing.

In summary, this special kind of napper says he falls asleep less readily and typically sleeps less at night than the other two napper groups. The shorter sleep is almost entirely a function of the difficulty he sometimes has in falling asleep after he goes to bed: he goes to bed at the same time and gets up at the same time, but sleeps less because it takes him longer to fall asleep, at least on some nights. The fact that his falling asleep time is highly variable suggests that it is this falling asleep difficulty that may force him to nap on the following day, even if he would prefer not to. These findings are consistent with the notion that the napping of this subgroup is in response to specific insomnias. They rate themselves as often having a great deal more difficulty in falling asleep at night, and we would anticipate that it is these occasions (when they do have difficulty falling asleep at night) that leads to their subsequent, though less frequent, napping. Presumably they nap when they have to: fortunately they have the capacity to do so.

Napping in response to stress-induced insomnia. These results would seem to support the decision, based on the systematic inconsistency between the questionnaire categorization and the results of the postexperimental inquiry to view these 9 subjects as a separate group. It would appear that they are indeed neither appetitive nor replacement nappers in the strict sense, having some of the qualities of both, but in other ways being more like non-nappers in the way they sleep.

These 9 special nappers answered the criterion question, "Do you nap even when you do not feel very tired?" as "definitely yes" or "possibly

yes" (whereas by definition replacement nappers answer "possibly no" or "definitely no"). For the true appetitive napper his response to this question means that he enjoys his nap regardless of the circumstances, that the nap is a pleasant experience to be enjoyed whenever possible, which satisfies even when there is no need for sleep. The group of subjects we have called stress nappers, however, are individuals who tend to develop mild nighttime insomnia in response to life stress situations. The nap they take on succeeding days has the superficial appearance of an attempt to replace lost sleep. However, on more careful examination it seems that these individuals may also nap in response to the same life stressors which were responsible for the nighttime insomnia. The anxiety reducing properties of taking a nap which we have reported in our earlier reports may help make napping for these individuals at least transiently effective as a coping mechanism.

Insofar as there is a tendency for the stress napper to nap on days following some nighttime sleep difficulties, these individuals resemble replacement nappers. However, daytime naps, both subjectively and objectively, seem only partially related to sleep loss and may satisfy psychological needs--in this regard, the stress napper resembles the appetitive napper. These individuals have somewhat less control over sleep onset than appetitive nappers but do have the capacity to nap when the need arises, particularly to use the opportunity as a temporary escape from stress. Nonetheless, stress related insomnia serves as an important mediator of their napping behavior.

Only indirect evidence relates to this hypothesis. The correlation between the higher rating that the subject can nap readily in times of stress,

with his rated ability to fall asleep readily, is +.50 ($p < .10$) for the stress napper, but -.55 ($p < .10$) for the appetitive napper. Thus, the appetitive napper who naps at times of stress also typically falls asleep at night very readily, but the stress napper rates himself often as not falling asleep readily at night. These two ratings do not correlate significantly for replacement nappers ($r = .22$) nor non-nappers ($r = .27$). In contrast, those few appetitive nappers who sometimes experience difficulty in falling asleep at night are less likely to nap than the majority of appetitive nappers who never have difficulty falling asleep ($r = .54$, $p < .10$). It is not possible to infer any conclusion regarding the temporal sequence of the stress-related nap and the nighttime sleep difficulty from these correlations.

Some of the within subgroup correlations (though highly subject to chance fluctuations) support the general interpretation put forth above. Stress ($r = .48$, $p < .10$) and appetitive nappers ($r = .53$, $p < .10$) who do nap when stressed are likely to report feeling sleepier earlier at night, whereas the replacement napper who naps when stressed tends to be an earlier riser ($r = .60$, $p < .05$). Non-nappers and appetitive and replacement nappers who rate themselves high on the "fall asleep readily" scale also report going to bed earlier ($r = -.64$, $-.55$, and $-.58$, respectively, $p < .05$, $p < .10$, $p < .10$) and falling asleep more quickly ($r = -.66$, $-.67$, $-.70$, respectively, each $p < .05$). However, the corresponding correlations for stress nappers are .00 and -.17 respectively. Those stress nappers who typically took longer to fall asleep napped more frequently ($r = .85$, $p < .01$). These subjects also were more likely to awaken from a

nap feeling weary and tired in spite of the nap ($r = .81$, $p < .02$). They typically took very short naps. Their typical nap tended to be shorter ($r = -.54$, $p < .10$) if they had difficulty sleeping at night, whereas replacement nappers were likely to have longer naps ($r = .54$, $p < .05$) when they had falling asleep difficulties at night. Those stress nappers who more regularly report that many of their naps are involuntary were more likely to report that they often would have preferred not napping ($r = .63$, $p < .10$) and would prefer not to nap regularly, or every day ($r = -.65$, $p < .10$, $r = -.63$, $p < .10$). For those stress nappers who most frequently reported napping accidentally or involuntarily, their typical nap was shorter ($r = -.85$, $p < .01$), and they tended to nap less often ($r = -.63$, $p < .10$). In response to the question regarding when napping is most preferable, stress nappers who preferred to nap earlier in the day also typically slept less at night ($r = .65$, $p < .10$). All of these correlational findings contrasted with insignificant results for the appetitive and replacement nappers.

These findings seem to be consistent with a greater tendency by the stress nappers toward somewhat short unsatisfying naps which perhaps occur involuntarily. Perhaps they are compensatory, accidental naps which occur in response to their (mild) insomnia problems. Whether such stress-induced insomnias are harbingers of subsequent development of serious pathology is not yet known.

The presumed tendency to nap involuntarily following stress-induced insomnia cannot be considered to be convincingly demonstrated at this point. On the third blue section of the questionnaire completed by the nappers, some

differences that could be predicted from this hypothesis were not confirmed. The mean rating of 2.22 in response to whether more naps occur accidentally or involuntarily did not differ from the ratings of 2.18 and 2.20 for the appetitive and replacement nappers respectively. Nor did the ratings in response to "Do you voluntarily like to nap when you have time?" differ among the subgroups. Thus, although napping does not differentially occur accidentally among the groups, when it does occur accidentally, the implications of this seem to be different for those stress nappers than for the other subjects. Nevertheless, some of the questions raised by this special subgroup require further investigation.

Characteristics of Laboratory Napping in Three Napper Groups

Physiological concomitants of napping. All subjects who participated in the laboratory study were asked to nap for one hour. In general, the results indicated that the EEG sleep characteristics of the nap for both replacement nappers and the non-nappers were similar to segments of nighttime sleep. However, relatively little stage 4 delta sleep was seen, although about a quarter of the total sleep time was spent in stage 3 (defined as slow wave sleep in which less than 50% delta activity was apparent). Little evidence of REM was obtained in any subgroup although this was expected, as REM latency is usually around 90 minutes in both nighttime and napping sleep (except possibly for early morning naps which seem more likely a continuation of end-of-the-night sleep). The most important finding was that the appetitive nappers tended not to consolidate sleep, but rather frequently cycled through awake, sleep onset, stage 1 and stage 2. Some of the more relevant comparisons between the stress nappers and the other subgroups are

presented in Table 5.

Of the 9 subjects in the special subgroup that we have tentatively labeled stress nappers, two did not fall asleep and were excluded from the analysis. In general, the EEG characteristics of the nap for this group were virtually identical to those of the replacement napper and non-napper subgroups. Relatively few epochs (4.0) of consolidated sleep during the average 34 minute nap were observed (the comparable figures for replacement nappers and non-nappers were 5.7 and 4.7 epochs for total sleep times of 42 and 33 minutes). Each of these subgroups had significantly fewer epochs than the appetitive subgroups (11.1 epochs observed in the cycling of appetitive nappers) during their 40 minute naps.

Both the appetitive and replacement nappers fell asleep significantly more quickly (13.6 and 11.6 minutes, respectively) than either the non-nappers or stress nappers (25.7 and 26.6 minutes, respectively). This particular finding is important because it confirms the questionnaire reports of the ease of falling asleep that basically discriminates nappers from non-nappers, and it is also consistent with the findings that suggest the stress nappers do not have this capacity as strongly as other subjects who frequently nap.

Other physiological changes. Compared with non-nappers, the stress nappers are more like other nappers in their significantly lower oral temperature and (non-significantly) higher alpha density before the nap. However, for this subgroup these measures show less change from before to after the nap. Indeed, this subgroup was the only subgroup that did not change in level of resting skin potential between the beginning and end of

Table 5

Parameters of EEG Sleep in Nappers and

Non-Nappers During 60 Minute Daytime Nap

EEG Variable	Non-Napper N = 12	Napper Group			t-tests
		Appet. A = 11	Replace. R = 10	Stress S = 9	
Sleep onset (mins.)	25.7	13.6	11.6	20.6	(A,R) < (N,S)
Time in Stage 1	3.4	8.1	4.4	4.3	A > (N,R,S)
Time in Stage 2	16.5	16.0	18.6	18.0	
Time in Stage 3 + 4	13.1	15.7	19.0	11.4	
Total sleep time	33.0	39.8	42.0	33.7	R > N*
No. of Stage 1 epochs	2.7	7.0	2.6	1.9	A > (R,S,N)
No. of Stage 2 epochs	1.3	2.6	1.9	1.1	A > (N,S)
No. of Stage 3 epochs	.6	.9	.8	.6	
No. of awakenings > 3 min.	0.1	0.6	0.4	0.4	A > N*

Note:-All differences $p < .05$ (2-tailed) or better, except where * indicates $p < .10$ for specific comparisons. Groups enclosed in parentheses indicate that each of the subgroups differs from the other group(s) opposite the inequality sign.

the nap period. While this data must be interpreted with caution, there are some hints that these nappers were, like the non-nappers, more aroused before the nap, but showed relatively little change in arousal following the nap. While their usual nap may be an attempt to make up sleep in response to stress-induced insomnia, at least the nap does not have the effect of diminishing pre-existing physiological arousal levels. (The appetitive napper also showed relatively less change in physiological arousal than the replacement napper although this is not surprising in view of the fact that the appetitive napper naps in lighter stages of sleep.)

Sleepiness and nap satisfaction. Both appetitive and stress nappers rated themselves as being significantly sleepier than non-nappers ($p < .10$, $p < .02$) before the nap. However, all three napper groups, but not the non-nappers, rated themselves significantly less sleepy at the end of the nap ($p < .005$, $p < .05$, $p < .001$ for the appetitive, replacement and stress nappers, respectively). For both the appetitive and stress nappers, the decreased sleepiness was apparent only after the electrodes were removed, but not in their ratings within a few seconds of being awakened. All three napper groups rated depth of sleep similarly and were equally well satisfied with their nap. Thus, the stress napper obtains as much subjective benefit from the nap as the other napping groups even though he shows less changes in arousal level. As we noted before, the non-nappers reported no subjective satisfaction or benefit from the nap. In general, this special napping subgroup did not differ from replacement nappers or non-nappers in the several EEG and phone reaction time measures of arousal upon awakening. Each of

the groups differed from the appetitive nappers, again probably because of the lighter sleep of the appetitive nappers.

Suggestive correlational data concerning nap satisfaction. In our previous report, we commented on some tentative correlational data that gave hints of important relationships among the three subgroups and various aspects of the nap that were primarily intended to create hypotheses for our future studies. With the same cautions about the difficulty of drawing inferences from such extremely small samples, a couple of the correlations involving the special subgroup of nappers are worth summarizing. Only those correlations that differ markedly from the other subgroups are commented upon.

The slowness of arousal from the nap in terms of telephone reaction time, preceding length of delta sleep, and total sleep time, each correlated about .6 with the ratings of recovery from fatigue. Similarly, the stress nappers tended to base their sleep satisfaction ratings on sleep parameters, particularly fast sleep onset (-.60, $p < .20$), longer stage 2 time (.76, $p < .10$), stage 3 time (.65, $p < .15$), and total sleep time (.72, $p < .10$), as well as still being asleep at the end of the session (.77, $p < .10$). However, like the other nappers, this subgroup was more satisfied with their nap if they had a slower arousal reaction time to the telephone (.70, $p < .10$). Thus it appears that the degree of recovery of fatigue and the satisfaction of the nap were significantly related to the parameters of sleep for the stress nappers, although this was not found to be true for the other three subgroups.

On combining these findings with the tentative findings reported last year, and at the risk of over-generalization for the sake of generating future hypotheses, the following variables for each of the groups seem to be differentially related to nap satisfaction: (a) the swift passage of time for the appetitive nappers, (b) rapid onset, deep sleep, and arousal disorientation for the replacement nappers, (c) length of EEG sleep stages and total length of sleep for the stress nappers (even though these subjects have great difficulty in estimating the passage of time) and (d) metabolic factors (low oral temperature, EEG relaxation, etc.) along with post-nap disorientation for the non-napper.

Time estimation. One of the more intriguing findings of several of our previous napping studies is that nappers and non-nappers may be using different criteria for what they consider to be sleep, at least while napping. Thus, if stage 1 onset is excluded from the EEG criterion of sleep, nappers estimate the length of their nap more accurately than non-nappers. The reverse is true if stage 1 onset is included. While the data in this study for the three groups reported last year was less clear-cut, for possibly several reasons, the same trends were found. It is therefore particularly striking that the stress napper subgroup made poorer estimates of their nap-length than all other subjects and they also tended to underestimate sleep onset time more than any other groups. The fact that the stress nappers underestimate sleep onset time, but overestimate total sleep time, may explain the puzzling questionnaire data that seemed to show that these subjects report falling asleep easily in a variety of situations even though they report

a history of sleep disturbances at least in terms of estimated sleep onset and total sleep time.

15-Day Sleep Diaries in the Stress Nappers

All of the subjects who completed the laboratory nap were asked to complete a sleep diary that was designed to collect information about typical sleep habits and napping patterns over a 15-day period. There were some specific findings that shed light on the nature of the stress nappers and the ways in which they differed from the other two kinds of nappers.

More variability in napping behavior was found for the stress nappers than for the other two subgroups. They napped less often and were less consistent in terms of how long the nap was and what time of the day it was taken. Other nappers seem to nap for a shorter period as the time of the nap gets later in the day. No such systematic differences were found for this special group. Indeed, during the 15-day period, 16% of all of the stress nappers napped after 8 P.M. (some even after midnight); less than 2% of naps were reported after 8 P.M. in the other two napper groups.

Last year we reported that both appetitive and replacement nappers averaged more total sleep in the 24-hour day period (but not at night) than non-nappers; the stress nappers slept in much the same way as non-nappers and indeed have slightly less average nighttime sleep and 24-hour total sleep than even the non-nappers. In spite of some of their difficulties in estimating sleep length, the records from the diary confirm the questionnaire data that this group of subjects typically ends up with less sleep than other people--even if the time they spend napping is added in. These data

suggest that their naps are more than just replacement sleep, but may indeed be a response to a mild but chronic problem of sleep deprivation.

Last year we reported that the sleep diaries confirmed our observations that the replacement napper, unlike the appetitive napper, does indeed nap to make up for lost sleep time. The results of the sleep diaries from the stress nappers also substantiate our notion that he naps in response to a general disturbance of sleep. The stress napper states that he did not sleep well either on the night preceding the nap or the night following the nap compared to the corresponding nights not associated with a nap ($t = 2.92$, $p < .02$; $t = 2.31$, $p < .05$). Compared to nights following days in which naps did not occur, the stress napper sleeps about 38 minutes less after he takes a nap ($t = 2.02$, $p < .10$) and rates himself as sleeping less deeply the night after the nap ($t = 1.94$, $p < .10$). These results would seem to suggest that the nap is not entirely successful in achieving whatever function it is supposed to serve for these subjects. Regardless of the circumstances under which he takes a nap, the nap itself apparently causes a somewhat abbreviated and restless night's sleep following the nap.

Thus, the sleep diary results indicate that (a) appetitive napping is unrelated to the sleep characteristics of the surrounding night, (b) replacement napping occurs in response to an abbreviated previous night's sleep, and (c) stress napping is a response to disturbed sleep patterns both before and after the nap is taken.

Last year we also reported some data on the consequences of napping on the subsequent night's sleep as well as the effect of the preceding night's

sleep on the likelihood of napping or non-napping and on the likelihood of whether a short or long nap was taken. For example, we reported that replacement nappers took a longer nap if they had a particularly short night's sleep the night before ($p < .01$). While napping tends to interfere slightly with total sleep length and sleep onset time that night in the appetitive napper, this is true of a short nap rather than a long nap. These data seemed to suggest that a shorter nap for an appetitive person had more of the qualities of a replacement nap, and it is not completely implausible that appetitive nappers may *sometimes* nap for purely replacement purposes. However, when an appetitive napper has a long nap, that nap bears no relationship at all to sleep parameters of the preceding or following night. In marked contrast, in terms of sleep onset, sleep length, and the number of times awakened during the night, the sleep of the stress napper subjects is quite disturbed on the night preceding a nap. In turn, the nap, particularly if it is a long one, tends to produce similar though less pronounced sleep disturbances on the following night. For these people napping may be counterproductive because it creates subsequent sleep problems of the kind that initially led to the need to nap. Whether their naps could be more productive if rescheduled at more appropriate times, possibly by reducing anxiety or by helping recover from the insomnia-induced sleep debt, requires further study.

Stress Napping and Sleep Questionnaire Factors

If this special type of stress-induced napping is a relatively unsuccessful attempt to replace temporary sleep loss, several predictions can be

made about the responses of each of the napping groups in relation to the five factor-analytic dimensions isolated in our previous work on an independent sleep questionnaire (Evans, 1976). We have recently scored the sleep questionnaires of these subjects in the standard manner, and the scores of the three napper groups, as well as the non-nappers for each of the five scale scores are summarized in Table 6.

It was predicted that there would be overall differences between the four subgroups on two (and possibly three) of the dimensions: the voluntary control of sleep and sleep onset difficulty (evidence about whether the problems of the stress napper would generalize to include poor performance on the sleep maintenance scale was not available). In fact, the F ratios for the weighted means comparisons across the four subgroups (df = 3, 35) for the control of sleep and sleep onset difficulty scales of 14.73 and 2.60 ($p < .001$, $p < .10$, respectively) confirmed these predictions (the F ratios for the sleep maintenance, dream recall and cognitive control scales were quite insignificant).

For the two scales where differences occurred, the following predictions, evaluated by appropriate post hoc t tests, were made and tested.

Control of sleep. Stress nappers should have lower scores on the voluntary control of sleep scale than replacement and particularly appetitive nappers, but higher than the scores of the non-nappers. As can be seen in Table 6, the four means fell in the predicted order. Non-nappers scored significantly lower than appetitive, replacement and stress nappers ($t = 6.64$, $p < .0001$; $t = 5.48$, $p < .0001$; $t = 3.48$, $p < .005$, respectively). Stress nappers

Table 6

Scores on the Sleep Questionnaire Factors in Non-Nappers and in Three Subgroups of Nappers who Napped for 1 Hour in the Sleep Laboratory

Sleep Questionnaire Dimension	Non-Nappers N=12	Napper Type			F (3,35)
		Appet. N=7	Replac. N=8	Stress N=9	
Voluntary control of sleep	10.0	16.0	14.9	13.4	14.74 $p < .001$
Sleep onset difficulty	13.2	11.0	10.5	13.2	2.60 $p < .10$
Sleep maintenance diff.	15.1	13.9	12.6	15.4	1.30 ns
Dream recall	16.0	15.9	16.1	16.6	.15 ns
Cog. control of ment.	9.4	9.1	11.3	10.8	1.11 ns

scored significantly lower than appetitive nappers ($t = 2.30$, $p < .025$), although the intermediate score of the replacement group did not differ significantly from either the higher appetitive or lower stress napper scores.

Sleep onset difficulty. Stress nappers should have significantly lower scores on the sleep onset difficulty scale than either replacement or appetitive nappers (although no prediction was made about how they would score compared to non-nappers). The predictions were essentially confirmed. Although there is no difference between stress nappers and non-nappers, both scored significantly higher than replacement ($t = 2.02$, $p < .05$; $t = 2.57$, $p < .005$) and appetitive nappers ($t = 2.15$, $p < .025$; $t = 1.67$, $p < .10$).

Thus, the available data, even on relatively small samples, confirms the predictions that stress nappers have relatively less voluntary control of sleep processes than replacement and particularly appetitive nappers, but more control than non-nappers. They also have significantly more sleep onset difficulties than either replacement or appetitive nappers. It should be noted, however, that responses on this questionnaire refer to general tendencies and do not reflect the variability in the patterns of sleep that we suspect is important with the stress nappers.

Stress Napping: Summary and Implications

The number of comparisons and the complexity of the data make it difficult at this stage to derive a clear-cut picture of the nature of napping in this somewhat puzzling subgroup. These 9 subjects do not consistently behave like any of the other three groups on the napping questionnaire,

general sleep habits questionnaire, during the laboratory nap, or when filling in the 15-day sleep diaries. Nevertheless there are some characteristics in which they are similar to each of the other subgroups.

The nighttime sleep habits of this group are in general more like the non-nappers than any other group, particularly in terms of sleep onset and sleep length. Overall, these subjects sleep less than all of the other subjects, and it is possible that they suffer from mild chronic sleep deprivation; thus, napping would seem to have replacement qualities for them. However, there were other hints that the reported sleep disturbances were quite variable in occurrence, and differed from time to time in their severity.

This subgroup of nappers share some of the characteristics of the voluntary control of sleep that is a striking feature of nappers in general. However, the ability is not as well developed, and in fact they do not seem to have as much control over sleep processes as the other nappers. Thus, to what extent napping can have positive benefits for this subgroup is not yet clear.

These subjects were picked out on the napping questionnaire as appetitive nappers in that they claim that sleep need is not their primary reason for napping. They are also most likely to nap in response to stress. In this sense they are similar to the appetitive nappers and are napping in response to psychological variables. The appetitive napper seems to derive a good deal of satisfaction and even psychological benefit from the nap--benefits which are not related to his subjective sleep needs and his 15-day nighttime sleep habits. The nap of this special stress napper subgroup

seems to occur as a sleep-need consequence of psychological problems rather than serving, as it does the appetitive napper, as a means of obtaining psychological benefits. Thus, napping of necessity rather than napping by choice may differentiate the stress and appetitive naps. The evidence tentatively suggests that the nap of the stress napper is quite unsuccessful in solving the kinds of problems that may have led to it. These subjects do not show any decrease in arousal *following a nap*, yet the nap itself does not necessarily prevent sleep disturbances the following night: sleep disturbances that already occurred the night before the nap. Nevertheless, they report being satisfied with the nap.

Given the common occurrence of sleep disturbances in a wide variety of psychopathology, the question must be raised whether the stress-induced insomnia and the consequent need to nap to overcome temporary sleep deprivation are harbingers of psychopathology. Although we do not have appropriate measures of personality and mental status on these subjects, one interesting clue is provided by the problems these subjects apparently had in estimating sleep onset time and nap length in the 1-hour laboratory nap. In a comprehensive review, Doob (1970) concluded that the negative correlation between psychopathology and accuracy of time estimation has not been supported in all studies. However, Culbert (1954) found that, compared to a control group who relatively accurately estimated a 2-minute interval when they were unexpectedly asked how long they had been waiting for an experimenter, subjects who had been made situationally anxious markedly misestimated the 2-minute interval, in some cases by as

much as 20 minutes. Kales, Kales and Bixler (1974) have confirmed in EEG studies a related finding well known to clinicians treating sleep disorders: chronic insomniac patients have an incredibly poor ability to estimate how much sleep they actually obtain per 24-hour period. Thus, the misperception of nap length in these subjects is consistent with a picture implying they may potentially be psychologically disturbed.

It is our hypothesis that there are stress factors which produce the sleep disturbances that lead to the need to nap. To the extent that these subjects have some capacity to nap at will, their napping is in fact an attempt to obtain similar benefits that are gained by the replacement nappers when they nap. Indeed, the EEG structure of their nap is similar to that of the replacement napper. However, these subjects differ from the replacement napper not in terms of the functions being served by their attempt to nap to recover from fatigue, but rather in terms of how the need arose in the first place and in terms of the consequences of the nap. For these special nappers, sleep loss is a function of at least temporary psychological disturbances, whereas we suspect that for the typical replacement napper the sleep need is created by those myriad of normal factors that often lead a person to fail to have enough sleep on some occasions.

Napping, Control of Sleep, and Responsivity to Hypnosis

Dimensions of Sleep Efficiency

In a previous progress report, we presented results of a factor analytic investigation of a questionnaire that has routinely been used in our laboratory to explore some of the parameters of subjects' typical sleep habits. In that

study five independent clusters of items were isolated and replicated in two samples (92 and 181 subjects). The most interesting cluster in terms of our current program was tentatively called voluntary control of sleep. Related questions included items involving: Falling asleep easily; Taking daytime naps; Going to sleep at will; Falling asleep during a movie or a concert, or on a plane or train trip. The largest contribution to reliable variance was made by a dimension involving dream recall, including questions about: Dreams every night; Dreams about daytime happenings; Dreams in color. Two separate dimensions seemed to involve different kinds of sleep problems. The first, sleep onset difficulty, included: Difficulty in falling asleep; Takes sleep medication; Nights of dreamless sleep; and Trouble sleeping before an exam. The second, inability to maintain sleep involved: Awakens at sounds; Often wakes up during the night; Has to get up at night; Light sleeper. The intriguing possibilities that these two dimensions represent normal manifestations of the more extreme sleep onset and sleep maintenance insomnias often noted in the differential diagnosis of depression and anxiety still need to be explored. The final dimension may be most relevant to our earlier work on information processing during sleep (Evans, Gustafson, O'Connell, Orne, & Shor, 1969)--the cognitive control of sleep mentation, including: Changes of dream content at will; Deciding beforehand what to dream about; Awakens to find sound in dream was real. A separate report on the above work has been submitted for publication (Evans, 1976).

In a collaborative pilot study conducted by Dr. Kenneth Graham

at Muhlenberg College, the questionnaire was administered to 20 subjects who sought help for sleep onset insomnia from the Student Health Service. The responses of these 20 insomniac patients on the control of sleep and sleep onset difficulty dimensions differed significantly from 20 control subjects ($p < .01$) for 10 of the 11 defining items. When the patients were then given short-term counseling, using a self-hypnotic relaxation procedure, six months after the treatment period the insomniac students had improved the degree of voluntary control over sleep ($p < .001$) on all the criterion questions. This change was paralleled by reports of significantly improved daily sleep patterns. These data present additional validation of the sleep questionnaire and its ability to tap the ability to control sleep onset, as well as indicating an important way in which skill at controlling sleep processes might be taught.

Control of sleep and hypnotizability. To the extent that the reported sleep changes are a function of the improvement in sleep quality rather than non-specific aspects of the therapeutic experimental procedure, these results indicate that at least some aspects of control over the process of sleep can be acquired by subjects given appropriate training, such as hypnotic relaxation. A more intriguing possibility is that there may be some relationship between the control of sleep dimension and susceptibility to hypnosis. Such a relationship might well be only a specific manifestation of individual differences in a much broader capacity to voluntarily control levels of awareness and altered states of consciousness in general. Falling asleep easily at night, the ability to nap, and the capacity to experience

hypnosis may involve interrelated mechanisms subsuming a general capacity to be able to successfully achieve changes in states of consciousness at will. Such a capacity might include other states such as meditation. It is interesting in this regard that EEG delta sleep has been observed during the meditation period of some experienced meditators (Albert & McNeece, 1974; Pagano, 1976; Younger, Adriance, & Berger, 1975).

We have been able to explore the relationship between the control of sleep mentation and hypnotizability in several samples. For example, in Table 7, mean scores on the Harvard Group Scale of Hypnotic Susceptibility, Form A (HGSHS:A) are presented for subjects who scored in approximately the upper and lower quartile of the estimated control of sleep factor scores. Data are reported for a sample of 60 subjects who volunteered for a hypnosis experiment, and also for a larger group drawn from three separate hypnosis studies. It is quite clear that subjects who are able to score high on the control of sleep cluster also have higher scores on HGSHS:A. A similar result is obtained when subjects are categorized in terms of high (9-12) and low (0-4) susceptibility on HGSHS:A. The mean scores on the control of sleep dimension are 14.8 and 12.6, respectively ($df = 39$, $t = 2.29$, $p < .01$) and 14.3 and 13.8 respectively ($df = 191$, $t = 1.30$, $p < .10$) for the smaller and combined samples.* These results clearly support the predicted relationship between hypnotizability and the voluntary control of sleep.

There were also significant differences for the small and combined

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*It should be noted that in two other large samples (combined N = 179), although similar trends were obtained, they were not significant. However, there were differences in the way these samples were recruited.

Table 7

Subjective Dimensions of Sleep and Susceptibility to Hypnosis

	HGSHS:A Sample 1			HGSHS:A 3 Samples		
	High N=28	Low N=12	t	High N=109	Low N=83	t
Voluntary control of sleep	14.8	12.6	2.39**	14.3	13.8	1.30
Dream recall	17.1	14.0	2.28**	16.8	15.3	3.33**
Sleep onset difficulty	11.8	13.2	1.65*	12.0	12.0	—
Sleep maintenance difficulty	14.8	13.2	1.61	14.4	14.4	—
Cognitive control of mentation	11.1	9.8	1.61	11.4	11.0	—

*$p < .10$; **$p < .02$ (two-tailed tests)

samples indicating that hypnotizable subjects scored higher on the dream recall dimension ($p < .02$ in both cases).

The nature of the relationship between hypnosis and the control of sleep is clarified in Table 8 which indicates the seven items (4 from the sleep control factor and 3 from the dream recall factor) that contribute to these differences. The correlation between hypnotizability and each of the items for the full sample of 60 is indicated, along with the means for each item (all scored on a 5-point scale where 5 = always, and 1 = never) for the high ($N = 28$) and low ($N = 12$) susceptible subjects.

Control of Sleep, Hypnotizability, and Napping

The items concerned with falling asleep easily and quickly at night and having the capacity to sleep in circumstances such as a movie theater, or concert, represent phenomena that were explored in more detail in the special questionnaire that was designed to look at the parameters of napping. Indeed, we expected a clear relationship between the control of sleep items, napping and hypnotic susceptibility. However, the obtained results were more complex, but perhaps more meaningful, than such a simple relationship would imply.

As already reported, the napping questionnaire was administered to 469 students who volunteered to participate in a hypnosis experiment. These subjects were divided according to the same criteria used in the previous report. Thus, non-nappers were subjects who indicated that they rarely or never napped ($N = 210$; 45%). The 259 nappers could be divided into appetitive and replacement subgroups ($N = 87$, $N = 172$, respectively) on the

Table 8

Differences between High and Low Hypnotizable Subjects on Sleep Questionnaire Items

Item Content[a]	High N=28	Low N=12	t	p<	r HGS:A N=60	p<
Do you dream at night	3.86	3.08	3.67	.0005	.45	.005
Have nights of dreamless sleep	2.82	3.42	-3.28	.005	-.29	.025
Change dream content at will	2.36	1.67	2.47	.01	.25	.05
Fall asleep easily	3.71	3.17	2.03	.01	.30	.01
Go to sleep at will	3.36	2.17	3.80	.0005	.51	.0001
Can sleep in movie theater, concert	1.82	1.33	2.25	.025	.25	.05
Hours sleep usually at night	7.54	8.08	-1.74	.05	-.23	.05

[a]All items scored 5 = always, 1 = never (one-tailed).

basis of their answers to the question, "Do you nap even when you do not feel tired?" Appetitive nappers answered this question "always" or "usually" while replacement nappers answered it "rarely" or "never."

It will be recalled that the napping questionnaire is divided into three sections. The first section was completed by all subjects. In addition, the nappers completed a separate section asking questions about their attitudes and about patterns of napping, and non-nappers completed a separate section concerned with their reasons for not wanting to nap. To our surprise, of the 76 comparisons made between high and low susceptible appetitive and replacement nappers, as well as similar comparisons for all nappers combined, only 6 borderline significant differences occurred. While this is probably a chance distribution of differences, insusceptible subjects reported they would like to sleep more, feel that they could go to sleep "right now" and would more like to nap daily than the hypnotizable subjects, while the hypnotizable subjects sleep less and tend to get up earlier in the morning and are more alert in the morning ($p < .05$ in each instance).

It is clear that nappers who differ in susceptibility to hypnosis do not basically have different patterns of sleep or napping, nor different attitudes towards napping. Both the high and low susceptible nappers tend to score equally highly on a number of items that are related to the voluntary control of sleep in a variety of circumstances; items which, as reported last year and replicated in this sample, clearly discriminate between nappers and non-nappers.

Hypnotizability and the Non-Napper

The comparison of high (N = 67) and low (N = 31) hypnotizable non-nappers, however, produced much more interesting results. In the separate section completed only by non-nappers on attitudes towards and reasons for non-napping, several questions significantly differentiated between high, medium, and low hypnotizable subjects.* These data (Table 9) show that the hypnotizable non-napper chooses not to nap primarily because he feels that he has no time to do so, it interferes with his work, and for some, that napping has unpleasant physical and possibly mental aftereffects. He feels that resting is more beneficial. The insusceptible non-nappers, however, give as a major reason for not napping that they would not be able to fall asleep.

These interesting findings (along with the concordant trends indicated in the footnote to Table 9 that did not reach significance) suggest that the hypnotizable non-napper does not nap because he does not want to do so However, it is likely that he could nap if he chose to do so. In contrast, the insusceptible non-napper probably does not nap because he does not seem to have the ability to do so even if he wanted to. In fact, differences between these two groups are quite analogous to findings summarized last year showing differences between non-nappers who previously in their life did nap compared to those who never did so.

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*The fact that medium subjects tend to actually fall in the middle in these and subsequent comparisons is a trivial, but important finding. One of the problems of previous studies seeking correlates of hypnotic susceptibility is that subjects of medium levels of susceptibility typically do not fall in the middle of high and low susceptible subjects on the relevant variable.

Table 9

Different Reasons for not Regularly Napping as a

Function of Susceptibility to Hypnosis Among Non-Nappers

Reason for not napping (5= definitely applies)	HGSHS:A High	Medium	Low	F	t (Hi vs Lo)
No time	3.42	3.34	2.68	3.10**	2.31**
Interferes with work	3.46	3.04	2.81	2.80*	2.22**
Not be able to fall asleep	2.48	3.12	3.16	4.73***	2.23**
Nap has unpleasant physical aftereffects	2.13	2.24	1.55	2.93*	2.26**
Rest more beneficial	2.56	2.31	1.90	2.44*	2.22**

*$p < .05$; **$p < .025$; ***$p < .01$

Note:— Reasons for not napping that do not discriminate levels of susceptibility include Napping is an unpleasant experience*, no need to nap$^{\phi}$, interferes with leisure$^{\phi}$, would not feel better afterwards, would not feel less tired afterwards, would not be able to sleep at night$^{\phi}$, get enough sleep now$^{\phi}$, napping is a sign of laziness*, and napping has unpleasant mental consequences*. In general, for categories marked * high subjects endorsed the statement more strongly than mediums, both of whom did so more than lows; for statements marked ϕ similarly insignificant trends were noted in which highs least often endorsed the statement as applicable.

These findings are extended in Table 10. This complex table summarizes the responses on the section of the napping questionnaire completed by all subjects. Data for high and low hypnotizable subjects are presented in the right-hand column regardless of their napping classification. In the middle column the results are broken down into high and low susceptible nappers (the final breakdown into appetitive and replacement nappers as noted above does not prove to be informative). In the left-hand column the high and low hypnotizable non-nappers are summarized.

There are several interesting aspects of this data. It is clear that hypnotizability is an important variable related to non-napping, but not to napping. Only 2 of the 15 comparisons between susceptible and insusceptible nappers are of borderline significance. However, the differences between high and low susceptible non-nappers largely relate to those questions that are concerned with the ability to control sleep in a variety of circumstances. Thus, highly susceptible non-nappers claim they can fall asleep easily at night and can readily fall asleep while reading a book, while studying, at a play or theater, or on a train or plane, at the movies, at a lecture, and while watching T.V. In fact, of the ten comparisons made about the conditions under which they can fall asleep readily, susceptible non-nappers answered "never," to only an average 2.45 of the 10 compared to 4.65 "never" responses of the insusceptible non-nappers ($p < .00001$).

It is also of some importance to note that on all of these questions, nappers score significantly higher than non-nappers. Indeed, almost all of these questions have means that have the same rank order: both high and

Table 10

The Moderating Effects of Being a Napper (N=259) or Non-Napper (N=210) on the Relationship Between Hypnotic Susceptibility (HGSHS:A--High=9-12; Low=0-4) and Subjective Sleep Questions Indicating Skill in Controlling Sleep

Sleep Item (Nap Questionnaire)	Non-Nappers Hi 67	Non-Nappers Lo 31	Non-Nappers t	Nappers Hi 85	Nappers Lo 36	Nappers t	All Ss Hi 152	All Ss Lo 67	All Ss t
Could sleep now (Yes=1)	.63	.42	1.99[b]	.79	.92	2.08[b]	.72	.69	----
Mins usually to fall asleep	19.2	28.8	1.90[a]	18.6	19.2	----	18.9	26.4	2.42[c]
Time usually to bed (am)	00:41	01:18	1.97[a]	00:36	00:55	----	00:38	01:06	2.12[b]
Hrs sleep regularly	7:15	7:37	1.95[a]	7:17	7:22	----	7:16	7:30	----
Fall asleep easily	3.64	3.13	2.56[c]	3.81	3.64	----	3.74	3.40	2.76[c]
Wake up nights	2.52	2.26	2.21[b]	2.67	2.72	----	2.61	2.51	----
Difficulty falling asleep	2.33	3.00	3.47[d]	2.34	2.47	----	2.34	2.72	2.94[c]
Do you fall asleep:									
Reading book	2.48	1.90	3.07[c]	2.75	2.97	----	2.63	2.48	----
Studying	2.40	1.94	2.29[b]	2.64	2.89	----	2.53	2.43	----
Play or theater	1.64	1.23	3.17[d]	1.73	1.78	----	1.69	1.52	----
Plane or train	2.54	1.90	2.84[c]	2.86	2.86	----	2.72	2.42	1.92[a]
Movies	1.97	1.48	3.12[c]	2.18	2.06	----	2.09	1.79	2.58[c]
Stress	1.79	1.58	----	2.18	1.86	1.66[a]	2.01	1.73	2.00[b]
Lectures, speeches	2.22	2.81	2.35[c]	2.44	2.61	----	2.34	2.24	----
Watching TV	2.64	2.13	2.17[b]	2.85	2.61	----	2.76	2.39	3.34[d]
# of 10 sit. always diff.	2.45	4.65	3.99[d]	1.46	1.58	----	1.89	3.00	3.14[d]
Sleep walk	1.28	1.16	----	1.32	1.08	3.15[d]	1.30	1.12	2.88[c]
Sleep talk	2.12	1.97	----	2.22	2.00	----	2.18	1.99	1.48

a. $p < .05$ b. $p < .025$ c. $p < .01$ d. $p < .001$ (all one-tailed values)

low susceptible nappers score higher than either of the non-napper groups. Thus our basic finding that nappers have greater voluntary control over sleep is not violated by these findings. The new finding is that although non-nappers generally have less control over sleep than frequent nappers, this difference is moderated by hypnotic susceptibility. Those non-nappers who have the ability to experience hypnosis have greater control over sleep processes than the insusceptible non-nappers.

The nature of this relationship is further clarified in Table 11 which summarizes the responses of nappers and non-nappers classified by susceptibility to hypnosis on the question that perhaps measures the control of sleep dimension best: "Do you fall asleep readily?" It is clear from the analysis of variance that the difference between nappers and non-nappers is significant ($p < .001$). The difference between high and low hypnotizability levels is also significant ($p < .001$). However, the interaction between the propensity for napping and susceptibility to hypnosis is quite insignificant. Indeed, the frequency of distribution of hypnotizability among nappers and non-nappers is identical ($\chi^2 = .02$ n.s.).

Summary and Implications for Future Studies

There are several possible interpretations of the moderating effect of hypnotizability on non-napping, but not on napping. Our own view is to postulate individual differences in an underlying ability to voluntarily alter one's state of consciousness or to choose what particular state of consciousness is most appropriate under given circumstances, coupled with the (possibly learned) skill in achie[illegible] that state when desired. However, this

Table 11

Response to Question: Do you fall asleep readily?

(5 = Always, 1 = Never) in Nappers and Non-Nappers

in Relation to their Susceptibility to Hypnosis

	HGSHS:A		
	High (9-12) (N = 152)	Low (0-4) (N = 67)	All Ss (N = 219)
Napper (N = 121)	3.81	3.64	3.76
Non-Napper (N = 98)	3.64	3.13	3.48
	3.74	3.40	3.63

Note:- F (Napper versus Non-Napper) = 7.55, $p < .005$
F (High versus low hypnosis) = 7.68, $p < .005$
F (Interaction: Hypnotizability vs. nap type) = 1.87, ns
χ^2 (Comparing 4 subgroup N's) = 0.02, ns

is a very general ability possessed by some people, and it may manifest itself in any of a number of circumstances. The person who possesses this ability may develop a variety of skills or coping styles to handle situations in everyday life when it is beneficial to function at different levels of consciousness. Some people may choose to nap; others may choose to enter a trance-like state, others may meditate, while others may rest, like the executive who takes a short time out with his feet on the desk. There are undoubtedly other altered states that can easily be substituted by the person who has the ability to produce them. However, which of these coping styles an individual uses may depend on a variety of factors, one of which may be the appropriate opportunity to learn the particular skill involved in the coping style he may prefer. Thus, some people learn to meditate and others can be taught to enter hypnosis more readily. At least as far as hypnosis is concerned, ultimately the "depth" of hypnosis that one can experience is dependent on the level of the underlying capacity for hypnosis. Similarly, learning to nap may be a special kind of skill, some of the parameters of which may be related to the time of day or the stage of sleep achieved that produces the most psychological benefit to the person.

It is also our hypothesis that these various skills are theoretically interchangeable and can potentially be readily taught to appropriate people. Even though a person chooses to nap rather than chooses to experience trance-like states, we feel that that same individual has the ability to do either. While he may choose not to nap because it interferes with his time

and work, this is a reality restriction invoked by the individual who knows he has other capabilities to achieve similar benefits. Thus, in the collaborative study with Dr. Graham, it was the hypnotizable subjects with mild sleep onset insomnia that benefitted most from relaxation training. This training in and of itself was sufficient to improve their scores on the control of sleep dimension.

Perhaps the most important consequence of the work reported here stems from an observation in the course of the analysis of the 15-day sleep diaries. We noted that several replacement nappers reported napping in anticipation of long uninterrupted periods of wakefulness. It occurred to us that prophylactic napping to help prevent future sleep debt might well be a skill, significantly expanding the ability of an individual for long periods of continuous performance. Compared to such an effect, the relatively small increments in performance associated with postnap behavior that we have seen in the course of our earlier work would fail to tap the major potential benefits associated with napping.

Recent work by Hartley (1974) has shown that three 80-minute periods of sleep distributed over a 24-hour period are more effective in preventing performance decrement than the same amount of sleep--4 hours--taken in one block. Not only is the successful napper able to distribute his sleep with significant potential gains in sleep efficiency but, even more important, he is able to utilize any available periods of varying duration when no demands are placed upon him for napping. A number of such periods inevitably occur even under circumstances generally considered

to demand continuous performance. Whereas individuals normally need to be tired to sleep, those who have learned to nap prophylactically are probably able to utilize select periods as they occur to minimize the effects of future sleep loss. This vantage point has helped shape the future directions of the proposed work.

The identification of coherent patterns of napping behavior provides the framework in which the utility of napping can be examined in more detail. While we have shown that even non-nappers are able to sleep in the laboratory under optimal circumstances, it now becomes appropriate to explore the ease of napping under more trying circumstances. Initially we intend to use simple external distractors such as noise and light, though eventually we may also need to explore the effect of psychological stressors which would normally be encountered in the life situation of the combat soldier. Past work leads us to believe that it will be possible to isolate a group of individuals who have the skill of napping at will even under adverse circumstances as opposed to others who, while able to nap in comfort, find it difficult to do so in a more hostile environment. Such individuals, which we anticipate represent the majority of college age individuals, will become the focus of our efforts to facilitate volitional control of sleep onset. Techniques such as relaxation training, training in self-hypnosis, EMG and theta feedback will then be evaluated. The findings of the collaborative study on the treatment of mild insomnia suggest that sleep discipline can be taught effectively. From such an approach, which will provide the methods for assessing the success of trained volitional

control of sleep, it will become appropriate to move toward the evaluation of prophylactic napping as a means of effectively augmenting continuous performance in a controlled laboratory setting. We would anticipate it will be possible to document a meaningful effect of this kind, and once this is accomplished, it would be relatively easy to adapt sleep discipline training to the field situation.

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